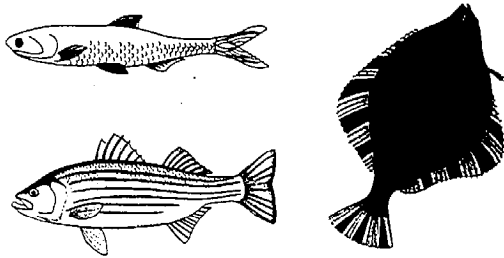


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# ◆ SUISUN MARSH/NORTH SAN FRANCISCO BAY ECOLOGICAL MANAGEMENT ZONE



## INTRODUCTION

Suisun Marsh and North San Francisco Bay are the portions of San Francisco Bay downstream of the Delta and upstream of Central San Francisco Bay. These areas include San Pablo and Suisun Bays, the adjacent Suisun Marsh, and the Contra Costa shoreline. North Bay was once bordered on the north by extensive marshes. Baylands alteration has now reduced the marshes to northern San Pablo Bay and Suisun Bay, including Petaluma, Napa, and Suisun marshes. Healthy marshes provide many ecological benefits including very high productivity, flood moderation and shoreline protection. Many of the tidal emergent marshes have been reclaimed for agriculture, salt production, duck clubs, and managed freshwater marshes. These lands are protected from flooding by hundreds of miles of levees. Remnants of the tidal salt marshes remain along the margins of San Pablo and Suisun Bay. The largest intact undiked wetlands remaining in Suisun Marsh are associated with Cutoff Slough and Hill Slough in north central Suisun Marsh.

Suisun Marsh and North San Francisco Bay support many species of native and non-native fish, waterfowl, shorebirds, and other wildlife. This ecological management zone also supports many native plant communities including several significant rare and endangered plants which are dependent of wetland processes. All Central Valley anadromous fish migrate through the North Bay and depend on the North Bay and marshes for some critical part of their life cycle. Many Pacific Flyway waterfowl and shorebirds pass through or winter in the North Bay

and marshes. The North Bay and adjacent marshes are important nursery grounds for many marine, estuarine and anadromous fish species. Four runs of chinook salmon, steelhead, green sturgeon, white sturgeon, striped bass, lamprey, and American shad migrate through the Delta on their journey between the Pacific Ocean and Central Valley spawning rivers. Young salmon may spend important weeks and months feeding in the North Bay and marshes before migrating to the ocean. Many sturgeon and striped bass spend much of their lives in the North Bay. Many marine (ocean) species depend on the North Bay as nursery area for young, including Pacific herring, northern anchovy, and Dungeness crab. Native resident fish, including longfin smelt, delta smelt, and splittail, spend much of their lives within the North Bay and marshes. Considerable areas of waterfowl and wildlife habitat occur on and along the margins of the North Bay and in the marshes.

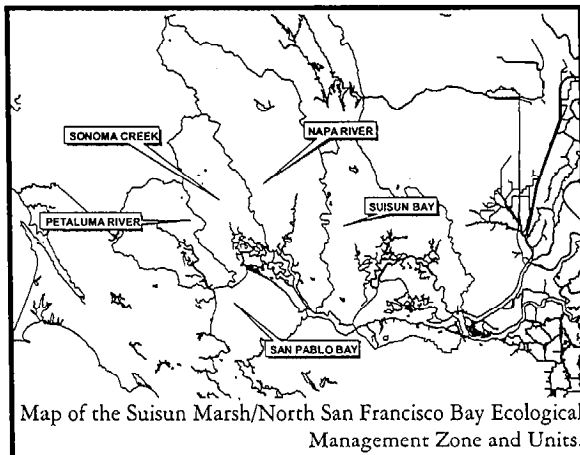
Ecological factors having the greatest influence on North Bay and marsh fish and wildlife include freshwater inflow from rivers, wetlands, riparian vegetation, and aquatic habitat diversity. Stressors include water diversions, poor water quality, legal and illegal harvest, wave and wake erosion, and introduced non-native plant and animal species. Stressors to Suisun and North Bay saline emergent plant communities supporting sensitive plant and wildlife resources include freshwater discharges which are outside of the natural variability of seasonal runoff. For example, fresh wastewater treatment outfalls sustained outside of the normal runoff season have been proven detrimental to saline emergent wetlands. Stressors may also include water management activities which result in increased depth and duration of flooding in high marsh zone beyond the range of natural variability and seasonality.

## DESCRIPTION OF THE MANAGEMENT ZONE

The Suisun Marsh/North San Francisco Bay Ecological Management Zone is the westernmost zone of the Ecosystem Restoration Program. Its

eastern boundary is the Collinsville area, and to the west it is bounded by the northwestern end of San Pablo Bay. The northern boundary follows the ridge tops of the Coast Ranges and includes the Petaluma River, Sonoma Creek, the Napa River, Suisun Bay and marsh and San Pablo Bay. This Ecological Management Zone is composed of five Ecological Management Units:

- Suisun Bay and Marsh,
- Napa River,
- Sonoma Creek,
- Petaluma River, and
- San Pablo Bay.



The general structure of San Francisco Bay is that of a series of embayments, each containing a central expanse of open water overlying subtidal sediments, and ringed by intertidal wetlands, mudflats, and/or rocky shores. These different kinds of areas constitute the major distinctive habitat-types of the ecosystem. Hydrologically, the Bay may be divided into two broad subdivisions with differing ecological characteristics: a *southern reach* consisting of South Bay, and a *northern reach* composed of Central, San Pablo, and Suisun Bays. The southern reach receives little freshwater discharge, leading to high salinity and poor circulation. It also has more extreme tides. The northern reach (which this vision addresses) directly receives Delta outflow, is characterized by less extreme tides and a pronounced horizontal salinity gradient, ranging from near full marine conditions in Central Bay to near fresh water conditions in Suisun Bay. Central and Suisun Bays contain sizeable islands. Features not present in San Pablo and South Bays.

Historically (ca 1800), San Francisco Bay included more than 242,000 acres of tidally influenced

bayland habitats and about 90,000 acres of adjacent habitats (Goals Project 1999). Tidal marsh (190,000 acres) and tidal flats (50,000 acres) accounted for 98% of the bayland habitats. Today, only 70,000 acres remain. In the Suisun Bay and marsh, tidal marsh and tidal flat habitats have declined from 68,000 acres to about 15,000 acres. Similar declines have occurred in the North Bay region with tidal marsh and tidal flats declining from about 68,000 acres to about 25,000 acres (Goals Project 1999).

Today, the important habitat types in the Suisun Marsh/North San Francisco Bay Ecological Management Zone are tidal perennial aquatic habitat, tidal saline emergent wetland, seasonal wetland, perennial grassland, agricultural land, and riparian habitat. The separation of wetlands from tidal flows and the reclamation of emergent wetlands have altered ecological processes and functions in Suisun Marsh and the North Bay. Removing tidal action from the marsh and baylands soils has resulted in oxidation of the soil and, subsequently, subsidence (settling) of interior islands and adverse changes in wetland soils chemistry. Losing these processes and functions has reduced available habitat for native species of fish, plants, and wildlife; reduced water quality; and decreased the area available for dispersing flood waters and depositing suspended silt.

Species that have been affected include the salt marsh harvest mouse, California clapper rail, California black rail, waterfowl, shorebirds, Suisun shrew, and many other wildlife species. Many special-status plant species, including the soft-haired bird's beak, Suisun thistle, and Suisun aster, have also been adversely affected. Many species of native marine, estuarine, freshwater, and anadromous fish also depend on this habitat type for important parts of their life cycles. Fish species that continue to depend on tidal marshes and adjoining sloughs, mudflats and embayments include delta smelt, longfin smelt, chinook salmon, green sturgeon, white sturgeon, Pacific herring, starry flounder, splittail, and striped bass.

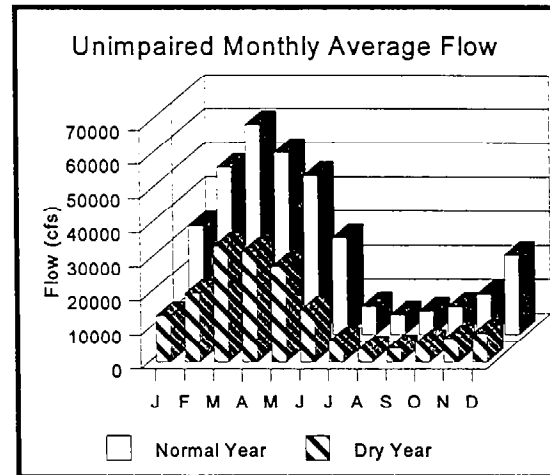
Submerged aquatic vegetation (SAV), especially seagrass, communities and habitats provide valuable habitat for fish and invertebrates in the San Pablo Bay and north San Francisco Bay and is an important foraging habitat for waterfowl. San Pablo Bay contains the greatest acreages of seagrass of any water body in the Bay-Delta system. The relative present-

day rarity of seagrass beds suggests it could be considered a habitat of special concern in the system.

Ecological processes essential to a healthy Suisun Marsh and San Francisco Bay include freshwater inflow, flood and floodplain processes, and aquatic foodweb processes. The disruption of ecological processes in this zone, such as separating wetlands from tidal flows, has prevented the marshes from the accretion of bottom sediments necessary to keep up with sea level rise, reduced nutrient input to the zone, and reduced the output of other organics and fixed nutrients. Ecological processes essential to a healthy Suisun Marsh and San Francisco Bay include both freshwater inflow within natural (unimpaired) variability and also tidal inflow to deliver important ocean salts and maintain this brackish-saline system. In addition, rare events such as extreme pulse flow hydrographs associated with high outflow years and rare events such as extreme winter drought conditions which this system experienced historically may be equally important in maintaining the biological diversity of this mixed salinity zone.

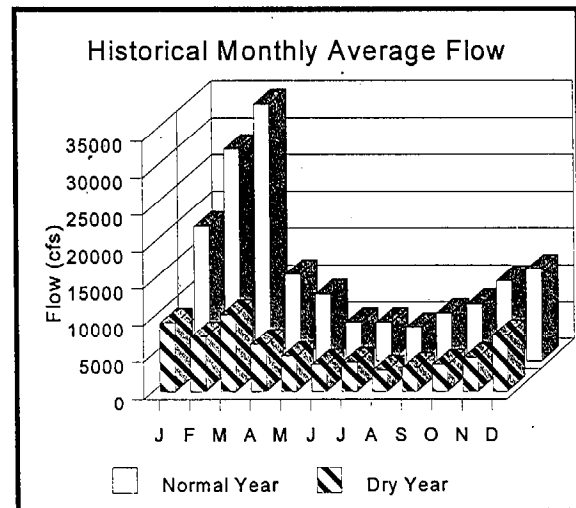
Hydrology is the physical process with the greatest influence on aquatic and wetland habitats, the many species of plants and animals that use the Bay, and the concentrations of pollutants in the marshes and North Bay. In areas downstream of the X2 isohaline (low salinity zone) which are well-mixed, ocean tides clearly dominate over and above freshwater inflow. The historical dominance of halophytic vegetation in Suisun Marsh also suggests that tidal hydrology may be more important to Suisun than freshwater inflows. The historical tidal prism prior to diking of the Suisun and North Bay marshes was also higher than present condition.

Freshwater inflow to the North Bay varies greatly from year to year. In 70 years of historical record, Bay inflow has ranged from a high of 50 million acre-feet (af) to a low of 8 million af, with an average of approximately 24 million af. During this period, freshwater inflow to the Bay has changed markedly because of upstream water storage in reservoirs and water-supply diversions developed in 1940s, 1950s, and 1960s. Spring freshwater inflows, which once averaged 20,000 to 40,000 cubic feet per second (cfs) in dry years and 40,000 to 60,000 cfs in normal years, now average only 6,000 to 10,000 cfs in dry years and 15,000 to 30,000 cfs in normal years. In the driest years, spring freshwater inflows from the



Unimpaired Delta Outflow, 1972-1992 (Dry year is the 20th percentile year; normal year is the 50th percentile or median year.)

Delta were formerly 8,000 to 14,000 cfs; presently these flows average only 2,500 to 3,000 cfs. In dry and normal years, summer flows have remained in the range of 4,000 to 8,000 cfs, because channels carry irrigation water and Delta outflow needed to meet water quality criteria in the Delta. Winter freshwater inflows from the Delta in dry and normal years have been reduced from former levels of 15,000 to 60,000 cfs to current levels of 7,000 to 35,000 cfs because much of the runoff from winter rains and snowmelt is now stored in foothill reservoirs. Flows in highest rainfall years are relatively unchanged, although short-term peaks are reduced by flood-control storage in large foothill reservoirs.



Historical Delta Outflow, 1972-1992 (Dry year is the 20th percentile year; normal year is the 50th percentile or median year.)

Freshwater inflows from the local watershed in the Vaca Mountains and Coast Range have also been modified from historic conditions. This influence, however, needs further review to clarify potential adverse downstream impacts.

Natural flood and floodplain processes are the periodic inundation of the floodplain during tidal cycles and peak flow events that would typically occur in late winter and spring during all but the driest years. Land reclamation and levee construction have eliminated much of the natural North Bay floodplain. This floodplain reduction forces water to rapidly exit the marshes and bays through confined channels and sloughs. While flows in most high rainfall years may be relatively unchanged, very large floods can devastate shoreline areas of the North Bay due to loss of floodplain and flood basin storage and other dampening effects of floods.

Aquatic foodweb productivity in the North Bay has declined over the past several decades due to several factors, including loss of tidal exchange, changes in freshwater inflow, Delta conditions, water diversions, water quality, and the introduction of exotic species. Foodweb productivity, beginning at the primary production level (i.e., plant cell production), is essential to maintaining important fish population. Primary productivity in the North Bay and adjacent marshes depends on spring freshwater flow events to bring in essential nutrients and recycle nutrients in the marshes. Primary productivity has been limited by heavy infestations of Asian clams that efficiently filter algae from the water column thus reducing the standing crop of phytoplankton.

With the reclamation of tidal marshes in the North Bay, there was an accompanying loss of shallow-water aquatic habitats on which many marine, estuarine resident and anadromous fish and estuarine invertebrates depend. Shallow-water habitats around the North Bay provide spawning and rearing habitat for many native resident Bay-Delta fishes and important rearing and migratory habitat for many Central Valley salmon and steelhead populations. Tidal perennial aquatic habitat benefits native waterfowl, wading and shorebirds, and other wildlife, as well as native plants that depend on such habitat.

Lakes and ponds (nontidal perennial aquatic habitats) found behind levees on reclaimed islands support simple invertebrate communities, riparian habitat,

and wintering waterfowl. Such habitat within the North Bay also benefits waterfowl, as well as many plant and wildlife species.

After more than 100 years of land reclamation activities in the North Bay and marshes, many linear miles of natural sloughs have been lost. Sloughs are important spawning and rearing areas for many Bay-Delta fish species, as well as waterfowl and other wildlife. Of the natural sloughs that remain, most have severely degraded natural habitat values from loss of the tidal prism, dredging, levee confinement, riparian vegetation loss, high water flow, and poor water quality (i.e., from municipal, industrial, and agricultural drains).

Tidal marshes (including tidal perennial aquatic habitat, saline emergent wetlands, tidally influenced fresh emergent wetlands, and sloughs), once the most widespread habitat in the Bay-Delta, are now restricted to remnant patches. There have been extensive losses of saline emergent wetland habitat in the North Bay and adjacent marshes. Most of the remaining saline emergent wetlands lack adjacent upland transition habitat and other attributes of fully functioning saline emergent wetlands because of agricultural practices and urban and industrial development. Saline emergent wetlands provide important habitat for many plants, waterfowl, and other wildlife species. In addition, saline emergent wetlands contribute important plant detritus and nutrient recycling to the aquatic foodweb of the Bay-Delta estuary, as well as important habitat to some fish and aquatic invertebrate species.

Seasonal wetlands include vernal pools, wet meadows or pastures, and other seasonally wetted habitats, such as managed duck clubs. Most of this habitat is located on levee-protected lands. Such habitats were once very abundant during the winter rainy season or after seasonal flooding. With reclamation, flooding occurs primarily from accumulation of rainwater behind levees, from directed overflow of flood waters to bypasses, or from flooding leveed lands (e.g., managed wetlands). Seasonal wetlands are important habitat to many waterfowl, shorebird, and other wildlife species.

Upland habitats are found mainly on the outer edges of the North Bay and adjacent marshes. They consist primarily of grasslands and remnant oak woodland and oak savanna (intermittent woodland and

grassland). Perennial grasslands are an important transition habitat for many wildlife species and are buffers to protect wetland and riparian habitats. Much of the grassland habitat associated with wetlands has been lost to agriculture (i.e., pasture, grain, vineyards, and orchards) and development (i.e., home construction, golf courses). Grasslands are important buffers for wetland habitat and provide habitat for many plant and animal species.

Riparian habitat, both forest and shrub, is found on the water and land side of levees, berms, berm islands, and in the interior of some islands. This habitat ranges in value from disturbed (i.e., sparse, low value) to relatively undisturbed (i.e., dense, diverse, high value). The highest value riparian habitat has a dense and diverse canopy structure with abundant leaf and invertebrate biomass. The canopy and large woody debris in adjacent aquatic habitat provide the shaded riverine aquatic habitat that many important fish and wildlife species depend on during some portion of their life cycles. The lower value riparian habitat is frequently mowed, disced, or sprayed with herbicides, resulting in a sparse habitat structure with low species diversity.

Riparian habitat is used by more wildlife than any other habitat type. From about 1850 to the turn of the century, most of the riparian forests in the Bay-Delta were cut down for fuelwood as a result of the Gold Rush, river navigation, and agricultural clearing. Remnant patches are found on levees, channel islands, and along the margins of the North Bay and adjacent marshes. Riparian habitats and their adjacent shaded riverine aquatic habitat benefit many fish and wildlife species.

Agricultural habitats also support populations of small animals, such as rodents, reptiles, and amphibians, and provide opportunities for foraging raptors (soaring birds of prey, such as hawks and eagles). Nonflooded fields and pastures are also habitat for pheasants, quail, and doves. The North Bay and adjacent marshes support a variety of wintering and breeding raptors. Preferred habitat consists of tall trees for nesting and perching near open agricultural fields, which support small rodents and insects for prey. Both pasture land and alfalfa fields support abundant rodent populations. The Swainson's hawk, a raptor species listed by the State as threatened, breeds and occasionally winters in the Bay-Delta.

Water diversions in the North Bay and adjacent marshes divert freshwater inflow and brackish waters. Though diversions vary seasonally, relatively high rates can occur in any month of the year. Most water diverted from the North Bay and marshes is used locally. With many diversions unscreened or poorly screened, great numbers of fish and aquatic invertebrates are lost. In addition to organisms, diversions remove a disproportionately large portion of the nutrients and detrital (organic debris) load that drive the Bay-Delta foodweb. Losses of fish, invertebrates, and nutrients and organic debris limit the potential for the recovery of many fish species and improving Bay-Delta aquatic foodweb productivity. Lack of adequate screening and location of water diversions in sensitive areas contribute to the loss of important fish and aquatic foodweb organisms.

Levee construction and bank protection have led to the loss of wetland and shallow-water habitat throughout the North Bay and adjacent marshes. Habitat on levees and shorelines needs improvement to restore biodiversity and ecological functions needed for Bay-Delta aquatic and wildlife resources. Riparian habitats in this zone are found along the tributary streams in the upper reaches. Riparian habitat is not generally found in areas subject to reclamation by levee construction due to high salinity.

Dredging and disposal of dredge materials have contributed to the loss and degradation of important aquatic habitats such as tidal wetlands, mudflats, and sloughs in the North Bay and adjacent marshes.

Over the past several decades, the accidental introduction of many marine and estuarine organisms from the ballast waters of ships from the Far East has greatly changed the planktonic and benthic invertebrate fauna of the Bay-Delta, with further ramifications higher in the foodweb. Further changes can be expected if restrictions are not made on ballast water releases into the San Francisco Bay and Delta.

Toxins continue to enter the North Bay and adjacent marshes in large amounts from municipal, industrial, and agricultural discharges. The toxins have had a demonstrated effect on the health, survival, and reproduction of many important Bay-Delta fish and their foodweb organisms. Toxins in fish tissues are also a health risk to people who eat Bay-Delta fish. Continued reductions of toxins from discharges and releases from the sediment (e.g., disturbed by natural

forces and dredging) are essential to the restoration program.

The legal and illegal fish harvest may limit recovery of some populations in the Bay-Delta and its watersheds. Sturgeon harvest in the North Bay and elsewhere may affect recovery of these populations.

Boat traffic in sloughs and channels contributes to the erosion of remaining shallow water, riparian, and wetland habitat. High boat speeds and traffic in channels where remnant or restored habitats are exposed to wave erosion jeopardize remnant habitat and limit the potential success of habitat restoration efforts. For example, an increase in jet ski use in Suisun Marsh following the improvement of local public launch facilities is also causing erosion and noise disturbance problems directly impacting sensitive channel side plant communities and nesting clapper rails in relict tidal marsh habitats.

The delta smelt population of the Bay-Delta estuary is a federally and state-listed threatened species. It depends on the North Bay and adjacent marshes for spawning and rearing habitat. It lives in fresh and brackish bays and sloughs of the Bay-Delta. Its decline is related to poor habitat conditions during drought periods. It benefits from high freshwater inflow, particularly during the late winter and spring of dry years, adequate slough and shallow water habitat, reduced effects of water diversions, and increased the aquatic foodweb productivity.

The longfin smelt populations of the Bay-Delta lives within the brackish water and saltwater of northern San Francisco Bay and migrate upstream into the Delta to spawn. The decline in the longfin smelt population has coincided with a number of changes in the estuary including: low flows in late winter and spring, reduced freshwater flows through the Delta and into Suisun Bay, water diversion (particularly in drier years), and contaminants.

Like delta smelt, splittail is a native resident species of the Bay that depends on the North Bay and adjacent marshes for much of its life cycle for spawning, rearing, and feeding. The splittail is a recently listed federal threatened species. The Bay-Delta population has declined, especially during recent droughts. Splittail depend primarily on shallow water habitats, including shorelines, sloughs, and aquatic habitats associated with wetlands and floodplain lands subject to seasonal inundation (e.g.,

the adjacent marshes of the North Bay). The splittail population benefits from wetland and slough habitat, a more productive aquatic foodweb, and higher late winter and spring freshwater flows during dry years. Losses to water diversions may also be a limiting factor.

White sturgeon and green sturgeon populations in the Central Valley use the North Bay for migrating, feeding, and as a nursery area for young and juveniles. Populations appear to be stable, but the green sturgeon is a California species of special concern due to low population size. Sturgeon benefit from high late winter and spring freshwater inflow, a productive aquatic foodweb, and bay habitat. Legal and illegal harvest and losses to water diversions may be limiting population abundance.

All four runs of chinook salmon in the Central Valley depend on the North Bay and adjacent marshes during at least a portion of their life cycle. The North Bay and adjacent marshes provide migratory and rearing habitat for salmon in all months. Many chinook salmon populations have declined in recent decades from a combination of ocean, river, and Bay-Delta factors. Freshwater flow reductions through the Bay-Delta and increases in water diversions have led to declines in salmon populations. Improving late winter and spring freshwater flows through the Bay-Delta and reducing losses to diversions are essential needs in salmon recovery.

Chinook salmon also benefit from lower water temperatures in spring and fall, as well as adequate aquatic habitats and high foodweb productivity. Tidal perennial marsh habitat and adjoining sloughs and aquatic habitats in the North Bay and adjacent marshes are important juvenile rearing habitat. Juvenile chinook salmon are lost to water diversions in North Bay and adjacent marshes.

Steelhead were historically present in the Napa River, Sonoma Creek, and Petaluma River Ecological Management Units, and are still present in most of these streams. The major factor limiting steelhead populations in these streams is agricultural development including water diversion, barriers due to diversion dams, high water temperatures and other water quality impacts from urban and agricultural runoff.

The striped bass population of San Francisco Bay and the Sacramento and San Joaquin rivers depends on

the North Bay and adjacent marshes for much of its life cycle. The North Bay and adjacent marshes provide important feeding and juvenile rearing habitat for striped bass. Reduced freshwater flow and increased water diversions have resulted in a declining striped bass population over the past several decades. Poor Bay-Delta water quality may also be limiting survival of young and adults. Striped bass also benefit from high aquatic foodweb productivity. Loss of tidal perennial aquatic, wetland, and slough habitats may also limit striped bass production. Many striped bass young are lost in water diversions. Artificially rearing young striped bass salvaged at south Delta pumping plant fish facilities or supplementing production with hatchery reared fish may be necessary to sustain the population under present limiting factors. —

American shad is an anadromous fish that spawns in the Sacramento River and its major tributaries. They pass through the Bay-Delta on their upstream spawning migration in spring, and in the fall, young fish pass through on their way to the ocean. A small portion of the population rears in North Bay waters. Though the population appears stable and healthy, low productivity in drought periods is a concern. American shad production is higher with higher late winter and spring freshwater flow through the Bay-Delta in dry and normal rainfall years, improved aquatic foodweb production, and lower relative rates of water diversions.

There are many native and non-native fish species resident to the Delta, like delta smelt and splittail, that will benefit from improved aquatic habitats and foodweb production in the Delta. Many native fish species have declined gradually over the past century from habitat loss and non-native fish introductions. More recently native resident (nonmigratory) species have further declined from changes in freshwater flow, water diversions, poor water quality, and further non-native species introductions and habitat degradation. For many of these species, improvements to their native habitats, including sloughs and tidal marshes, are essential in restoring these populations. Native residents will also benefit from more natural freshwater flow patterns, improved water quality, and reduced losses to water diversions.

Marine fishes include many species that are abundant and important ecologically in the Bay and coastal waters. Two ecologically valuable species are the

Pacific herring and northern anchovy, whose young are important in the foodweb as prey of salmon, sturgeon, and striped bass, as well as other fish and waterfowl such as cormorants and terns. Pacific herring, Dungeness crab, and Bay shrimp also support commercial fisheries. Starry flounder contribute to the local Bay-Delta sport fishery. The Bay and Delta are essential spawning and nursery areas for many marine fish and invertebrates found in the Bay and coastal waters.

Factors that affect the survival and production of marine fish and invertebrates in the Bay-Delta include Delta outflow, water diversions, foodweb productivity, availability and quality of shallow water and wetland habitats, and water quality. In addition, the aquatic foodweb is linked to the transitional wetland foodweb which extends up into the high marshes and adjacent uplands. These are important ecological links which contribute to the detrital based portion of the aquatic foodweb.

Improvements in production and survival of marine and estuarine fishes in the Bay and Delta will provide ancillary benefits to important estuarine, anadromous, and resident fishes of the Bay-Delta.

Many marine species depend on the North Bay and adjacent marshes for spawning or as nursery areas. Pacific herring spawn in the Bay each winter, and their young are abundant in the North Bay into summer. Young northern anchovy spawned in the ocean enter the North Bay each summer to feed. Starry flounder, shiner perch, and many other marine-estuarine fish also use the Bay for spawning, rearing, and feeding. Dungeness crab use the North Bay as a nursery area. Several shrimp species are abundant in the North Bay.

Bay-Delta aquatic foodweb organisms include bacteria, algae, zooplankton (e.g., copepods and cladocerans), epibenthic invertebrates (e.g., crayfish, Neomysis and Crangon shrimp), and benthic invertebrates (e.g., clams). Foodweb organisms are essential for the survival and productivity of fish, shorebird and other higher order animal populations in the Bay-Delta estuary. Some organisms are non-native species (e.g., certain zooplankton and Asian clams) that may be detrimental to native species and the foodweb in general. Recent declines in aquatic foodweb organisms of the Bay-Delta, particularly in drier years, has caused a reduction in overall Bay-

Delta productivity. Important aquatic foodweb organisms include algae, bacteria, rotifers, copepods, cladocera, and mysid shrimp.

Once possibly abundant, the giant garter snake and western pond turtle are now rare in the Bay-Delta. Improvements in wetland, riparian, and grassland habitats around the Delta margins could greatly benefit these species.

Once abundant in the Bay-Delta, Swainson's hawks are now rare. Improvements in agricultural, grasslands, and riparian habitats will aid in Swainson's hawk recovery.

The California clapper rail is State and federally listed as an endangered species. A long-term decline in tidal emergent wetlands has reduced the population in the Bay-Delta.

A long-term decline in emergent wetlands has reduced the California black rail population in the Delta. Restoring emergent wetlands in the Delta should aid in California black rail recovery.

The Suisun song sparrow lives only in the Suisun Bay marshes. It depends on brackish marsh and riparian habitats. Its population has declined with the loss of brackish marshes.

The salt marsh harvest mouse is a State and federally listed endangered species. It depends on tidal salt marshes and its population has declined with the loss of tidal salt marsh habitat.

Hérons, egrets, and other shorebirds and wading birds breed and winter throughout the Central Valley, the North Bay, and adjacent marshes. Their populations depend on aquatic and wetland habitats. Shorebirds and wading birds will benefit from restoring wetland, riparian, aquatic, and agricultural habitats.

Many waterfowl species overwinter in the Bay-Delta and depend on high-quality foraging habitat to replenish their energy reserves. They depend on wetland, riparian, aquatic, and agricultural habitats. Many resident and migratory waterfowl species will benefit from improved aquatic, wetland, riparian, and agricultural habitats.

### **LIST OF SPECIES TO BENEFIT FROM RESTORATION ACTIONS IN THE SUISUN MARSH/NORTH SAN FRANCISCO BAY ECOLOGICAL MANAGEMENT ZONE**

- delta smelt
- longfin smelt
- splittail
- chinook salmon
- steelhead trout
- striped bass
- green sturgeon
- white sturgeon
- American shad
- native resident fishes
- Pacific herring
- marine fishes and shellfishes
- Bay-Delta foodweb organisms
- grass shrimp
- special status plants
- California freshwater shrimp
- giant garter snake
- western pond turtle
- Swainson's hawk
- California clapper rail
- California black rail
- Suisun song sparrow
- salt marsh harvest mouse
- San Pablo California vole
- Suisun ornate shrew
- shorebirds
- wading birds
- waterfowl
- Delta green ground beetle
- Lamprey.

### **DESCRIPTIONS OF ECOLOGICAL MANAGEMENT UNITS**

#### **SUISUN BAY AND MARSH ECOLOGICAL MANAGEMENT UNIT**

The boundaries of the Suisun Bay and Marsh Ecological Management Unit are Collinsville on the east, the Contra Costa County shoreline to the south, the Benicia Bridge to the west, and the ridge tops of the Coast Ranges to the north. The marshland and bay are in a valley, bordered on the north and south by the Coast Ranges. The predominant habitat types